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A LEAF-CURL DISEASE OF OAKS.

With 1 plate and 3 text-figures.

E. MEAD WILCOX, Ph D. (Harvard).

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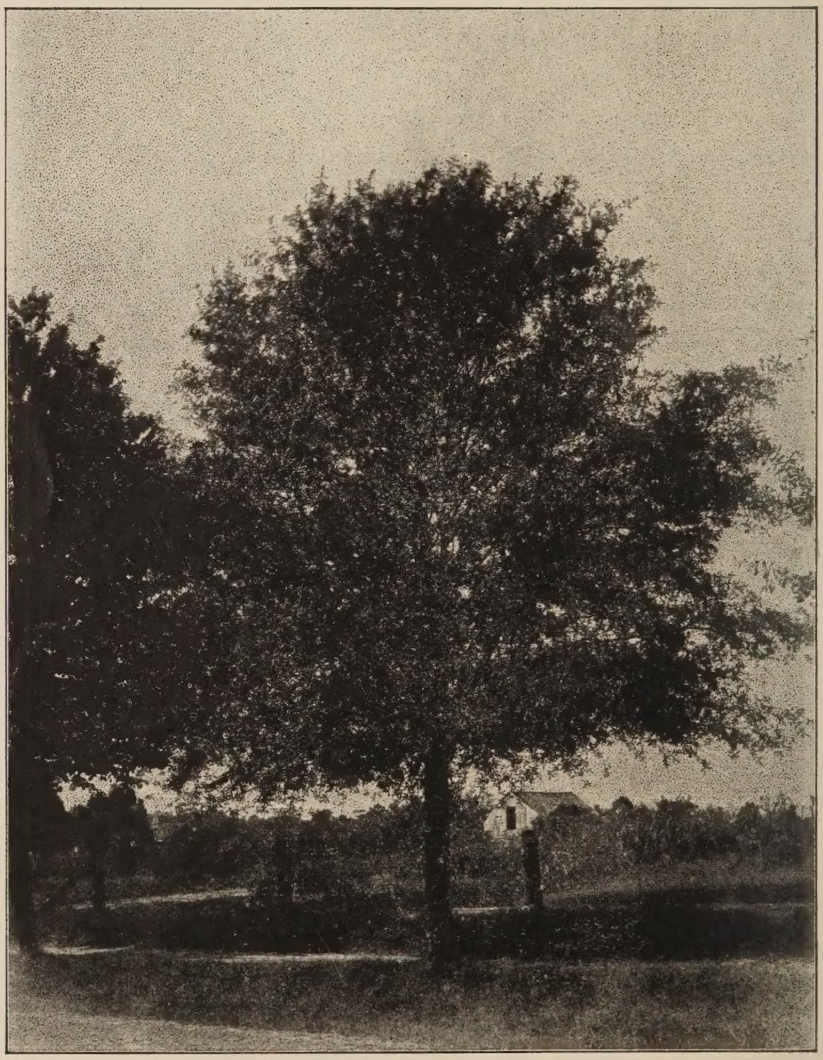

Plate 1.—Quercus nigra, one of the common shade trees in Alabama.

A LEAF-CURL DISEASE OF OAKS.

BY E. MEAD WILCOX.

Several of the native oaks are widely planted and highly prized in this State as shade trees both along city and town streets and about private dwellings. No small part of the beauty of a city or town is to be found in the number and character of the shade trees along its streets. While shade trees about private dwellings add much to the general appearance and attractiveness of the home and contribute largely to the comfort and pleasure of the occupants of the house. In fact, the general condition of the shade trees along the streets of any town may well be taken as a fairly accurate index of the prosperity and intelligence of the people of the community. Many of our people now appreciate the value of good shade trees and are desirous of protecting them against all their enemies. The purpose of the present bulletin is to call attention to one of the fungus diseases of some of our native oaks that threatens now to destroy many of these trees, particularly in our cities and towns. If, incidentally, more interest is aroused in home and city adornment through the agency of good shade trees, a useful purpose will have been accomplished in that direction.

It is a pleasure to acknowledge here the kindness of numerous correspondents in this and other States who have sent the writer specimens and notes of great value. I wish also to give expression here to my indebtedness to Dr. N. L. Britton, Director-in-chief of the N. Y. Botanic Gardens, and members of his staff, and Miss Josephine A. Clark, Librarian of the U. S. Department of Agriculture, for many exceptional favors and helpful assistance rendered in the consultation of the extensive litearture in their charge.

NATIVE OAKS USEFUL AS SHADE TREES IN THIS STATE.

The distribution over the state of the oaks that are most important for shade purposes in this state follows. Quotation marks enclose the statements made in Mohr's Plant Life of Alabama regarding the special habitat of each of the species. The species are arranged alphabetically by the scientific names.

SCARLET OAK. *Quercus coccinea* Muench).—This well known oak is frequent in the mountain region in "dry uplands, sandy and rocky soil."

LAUREL OAK. (*Quercus laurifolia* Michx—.This species occurs over the southern half of the state but is most characteristic of the central pine belt and the coast plain. It occurs in "low rich woods." This is one of our most highly prized shade trees on account of its evergreen foliage.

WATER OAK. (*Quercus nigra* L.)—This oak is rather common from the Tennessee river valley south to the coast occurring naturally in "low rich woods and sandy pine-barren swamps." This tree is very widely planted as a shade tree in every part of the state.

WILLOW OAK. (*Quercus phellos* L.)—This species is found from the Tennessee river valley southward to the central pine belt of the state but is not common in the southern half of the state. It occurs "in the bottom lands, borders of swamps. Most frequent in the coves of the Tennessee basin in low woods of a cold damp soil." This is also widely planted as a shade tree and in some towns practically to the exclusion of all other oaks.

BLACK OAK OR QUERCITRON OAK. (*Quercus velutina* Lam.)—This species occurs from the Tennessee

river valley south to the upper portion of the coast pine belt. The bark is the so-called "quercitron bark" employed for tanning and as a dyestuff while the timber is of some value.

LIVE OAK. (*Quercus virginiana* Mill.)—This oak occurs only in the coast plain district and rarely extends north of about 31°. This, one of the valuable timber and tanning trees of the state, is at times in the coast plain counties a very important shade tree.

SYMPTOMS OF THE DISEASE.

The disease now under consideration makes its appearance early in the spring before the new leaves are mature. A number of grey or bluish spots appear on the leaf and the more rapid growth of the parenchyma of the leaf at these points renders the surface convex on one side and concave on the other. The concave side of this spot or area is frequently on the upper side of the leaf but the spots on the same leaf may show variation in this regard. Some trees have been seen in which the great majority of the concavities were upon the lower surface but this is by no means the rule. These characteristic depressions, or "pockets," in the leaf result from the more rapid growth set up in that part of the leaf by the presence and action of the fungus causing the disease. These areas vary in diameter from 0.25 to 1 cm and are either isolated or confluent. In some of the narrow leaved oaks, such as *Quercus phellos* and *laurifolia,* it is not rare to find the spots confluent over so large a part of the whole leaf that the leaf is as badly curled as occurs in the peach leaf-curl, a closely related disease.

The rapid spread of the disease from one leaf to another may lead to a partial or even complete defoliation

of the tree in early summer. However serious the outbreak of the disease and the resulting defoliation may be, the tree generally attempts by the formation of new leaves to compensate itself for the foliage lost. In extreme cases of defoliation it is not uncommon to see a tree with an entirely new foliage covering in midsummer. In most cases the second growth of leaves is not so badly injured by the disease as was the first and it may entirely escape the attacks of the disease.

It is plain therefore from what has been said that the general effect of the disease upon the tree is much the same as defoliation due to any other cause. The effect of such a disease upon the life of the tree may best be appreciated when one recalls the fact that one of the most important functions of the leaves is to elaborate within their tissues the food material for use by the various parts of the plant in the building up of new tissues and other purposes. Even the roots are dependent upon the leaves for the food required for their growth and the defoliation of the tree may result in the most serious damage to the root system of the plant. Defoliation may result also in the great reduction of the growth in diameter of the stem, and particularly in the reduction in the amount of reserve food material stored up in stems, roots and buds for the following year's growth.

The second growth of leaves results from the proleptic development of buds intended for the following year's growth. And since, as just stated, these buds have had stored in them less food than usual owing to the diseased condition of the foliage of the tree, it is natural that the second growth of leaves developing from them should not be so luxuriant as was the first leaf covering of the tree. Under such conditions, therefore, the tree enters upon the second year's growth with a very small supply of reserve food material. The cumulative effect of the disease may therefore result in many cases in the death of the tree from actual starvation. It is very rare

however that the most severe attack of the disease will result in the death of the tree during the first year.

FUNGUS CAUSING THE DISEASE.

The fungus causing this disease is one of the lower *Ascomycetes*, a group characterized by the formation of its spores in small sacs of "asci," singular "ascus." This fungus is very closely related to the *Exoascus deformans* causing the well known leaf-curl disease of peaches. Unlike the latter our fungus does not possess a perennial mycelium and is carried over from one year to another entirely through the agency of the ascospores. These germinate in the spring and form a mycelium that spreads out beneath the cuticle of the leaves of the host to form there a more or less extensive network of hyphæ. From this vegetative mycelium the asci arise in large numbers. These are more or less cylindrical in form and are packed closely together side by side. See Fig. 1.

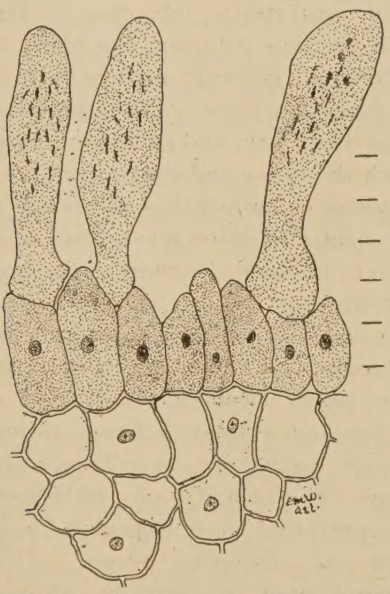

Fig. 1.—Cross section of a portion of a diseased leaf, showing the young asci of the fungus. Each division of the scale is equivalent to 10 mu.

The asci arise between the epidermal cells and the true cuticle and break through the cuticle toward maturity.

Each ascus contains at maturity a large number of small spores though it is probable that in younger stages the typical condition is the 8-spored ascus. These original 8 spores however multiply to a large extent within the ascus resulting in the much larger number that is to be found in the mature asci. The asci in the material we have examined are from 50 to 75 mu long and from 15 to 25 mu wide. The spores measured vary from 1.5 to 2.5 mu in diameter.

As has been mentioned in the discussion of the symptomoloy of the disease, the asci arise in small roundish areas upon the surface of the leaf. In the original description of this fungus Desmazieres states that the spots arise on the lower surface of the leaf but this is certainy not uniformly the case. We have noticed that in *Quercus velutina,* the black oak, the spots are generally upon the lower surface only. The same fact is recorded for this species by Robinson 1887. In *Quercus nigra,* the water oak, and some other species the spots occur on both the lower and upper surfaces of the leaves. In all the species examined these spots are at first rather definite but sooner or later several of the spots fuse together so that the spore bearing areas became very indefinite and large.

Like many of the fungi the species under consideration has been referred to under a rather large number of names in the past. Desmazieres in 1848 published the new genus *Ascomyces* Mont. & Desm. to include the single new species *Ascomyces coerulescens* Mont. & Desm. But the genus *Taphria* had been established by Fries in 1815 who assigned to it but one species, *Taphria populina,* now known as *Taphria aurea.* Fries in 1825, however, complicated matters by altering his first

published name *Taphria* to *Taphrina*, to avoid, as he stated at the time, confusion with Taphria a genus of insects. Tulasne in 1866 revised the genus *Taphrina* of Fries and made it include also the species of *Exoascus*. Robinson followed Tulasne and Johanson also in including all the species of the genera *Ascomyces* and *Taphrina* and *Exoascus* in the genus *Taphrina*, as extended by Tulasne.

In my judgment the plan followed by Schroeter 1894, in taking up the original genus *Taphria* Fries is by far the best and is in accord with present practices. Schroeter assigns to this genus all those species whose asci at maturity are multisporic and to the genus *Exoascus Fuckel* he assigns all those species whose asci at maturity are 8, or rarely 4, spored. In accordance with the above statements our species shold be written *Taphria coerulescens* (Mont. & Desm.) Schroeter, and the following would be its synonomy:

Ascomyces coerulescens Mont. & Desm. 1848.
Taphrina coerulescens (Mont. & Desm.) Tulasne. 1866.
Ascomyces quercus Cooke. 1878.
Ascomyces alutaceus Von Thuemen. 1879.
Exoascus coerulscens (Mont. & Desm.) Sadebeck. 1887.
Taphria coerulescens (Mont. & Desm.) Schroeter, 1894.

PREVENTION OF THE DISEASE.

The fungus causing the disease now under consideration is an annual and its mycelium does not perennate within the tissues of the host as is true of many of the closely related forms, such as the peach leaf-curl fungus. The treatment of such fungi is very much more readily carried out than is the case with perennial fungi,

a portion of whose mycelium lives over winter within the host plant itself. In fact in the case of the particular fungus causing this disease no part of the mycelium enters the host plant farther than directly beneath the cuticle of the leaf.

During the spring of 1902 an attempt was made to prevent the appearance of the disease upon a specimen of the water oak, *Quercus nigra*. The ordinary Bordeaux mixture was employed, made according to the following formula:

Copper sulfat or "blue vitrol".... 4 lbs.
Unslaked lime ..... 4 lbs.
Water .....50 gallons.

Place the copper in a coarse cloth sack and dissolve it by suspending the sack in a wooden vessel holding about 15 gallons of water. The lime is then to be slaked with just enough water to ensure thorough slaking. The slaked lime is then to be made into a paste having the consistency of thick cream by adding water and stirring. When the solutions thus prepared are cold the lime water is to be poured into the copper sulfat solution through a fine sieve. Water is then to be added to make the solution up to the required 50 gallons and the whole thoroughly stirred before and while using. If too little lime has been employed the solution may injure tender foliage and the potassium ferryconaid test should be applied to determine this point. The test consists in adding to a small sample of the prepared mixture a few drops of a solution of potassium ferrocyanid made by adding one part by weight of the salt to five parts of water. If, upon the addition of a few drops of this solution, the bordeaux mixture becomes a reddish-brown one may know that not enough lime has been employed in the preparation of the spraying solution. After the addition of more lime test again in the same manner and consider

the solution ready to use only when no discoloration appears after the addition of a few drops of the test solution to a small sample of the spraying mixture.

The tree employed in our experiment was thoroughly sprayed about ten days before the buds opened and then at intervals of ten days three more sprayings were given. The dates were as follows: February 26, March 9, March 18, and March 26. Of course the first and all subsequent dates must be determined by the advancement of the season. Although the sprayed tree was in close proximity to unsprayed trees of the same species that were badly injured by the disease, the sprayed tree was only very slightly affected by the disease. More extensive experiments must be undertaken before one could say with any certainty that this line of treatment will in all cases be effectual in preventing the outbreak of this disease. But the one positive demonstration of the value of this treatment renders it very probable that the disease may be held in check by such treatment as that outlined above. It is expected that further experiments along this line will be undertaken during the coming spring with several species of oaks that are known to have had this disease during the present season.

HOST INDEX OF THE FUNGUS.

The fungus now under consideration has been reported as occurring on the following species of oaks in the states named.

Quercus alba L. White Oak. Conn. N. J.

Quercus brevifolia (Lam.) Sargent. Blue Jack. Ala. S. Car.

Quercus coccinea Muench. N. J. Wisc.

Quercus digitata (Marsh.) Sudworth. Spanish Oak. Ala.

Quercus laurifolia Michx. Laurel Oak. Fla.
Quercus marylandica Muench. Black Jack. Ala.
Quercus minor (Marsh.) Sargent. Ala.
Quercus nigra L. Water Oak. Ala. Fla.
Quercus phellos L. Willow Oak. Ala. Fla.
Quercus rubra L. Red Oak. N. H. N. Y.

GEOGRAPHICAL DISTRIBUTION OF THE DISEASE.

The distribution of this disease by states is shown in Figure 2.

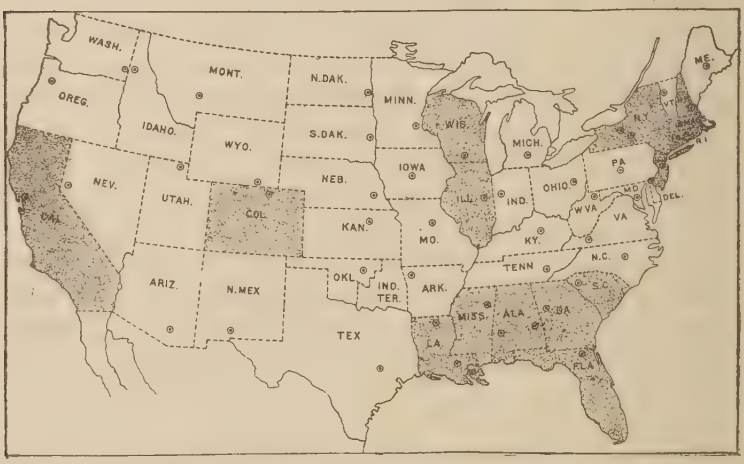

Fig. 2.—The disease described in this Bulletin is known to be present in the states shaded.

It is very likely that the particular fungus causing the disease herein considered is found outside of the areas there indicated but serious outbreaks of the disease are to be expected only in the gulf states. It would appear that the climatic and other conditions are in that region more favorable to the development of the fungus

than those prevailing to the north and west. Specimens of leaves showing the disease and the fungus herein described have been examined by the writer from the following States: Alabama, California, Colorado, Connecticut, Florida, Georgia, Illinois, Louisiana, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, Rhode Island, South Carolina and Wisconsin.

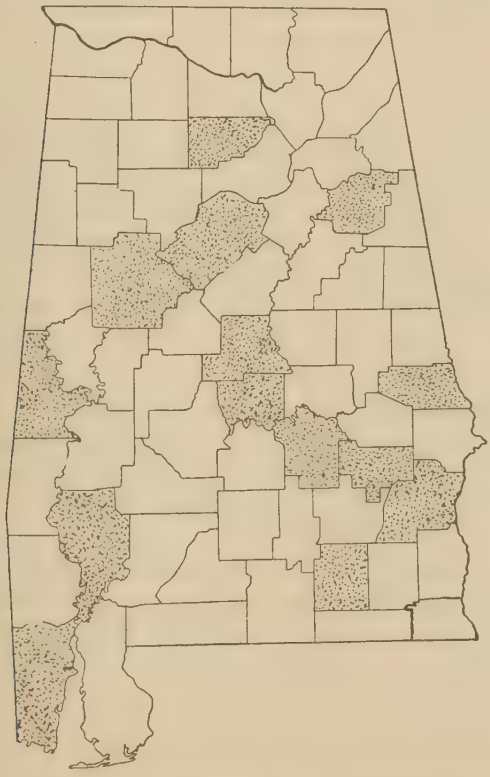

Fig. 3.—The disease described in this Bulletin is known to be present in the counties shaded.

In figure 3 is shown the local distribution of the disease in this State by counties so far as the writer has been able to examine material. The disease no doubt does much damage in every county of the State but particularly in the counties south of the Tennessee river valley. Material of the disease has been examined from the following counties: Autauga, Barbour, Bullock, Calhoun, Chilton, Clarke, Coffee, Cullman, Jefferson, Lee, Mobile, Montgomery, Sumter and Tuscaloosa.

OTHER SPECIES CLOSELY RELATED TO TAPHRIA COERULESCUS.

The following notes upon related species described as growing upon species of *Quercus* may be of interest.

Ascomyces extensus Peck .1886. Reported on leaves of *Quercus macrocarpa* from New York state.

Exoascus kruchii Vuillemin. 1891. This species was found by Kruch in Italy upon leaves of *Quercus ilicis*, and is by Schroeter referred to *Taphria*.

Ascomyces quercus Cooke. 1878. This was reported by Cook in Rovenel's American Fungi upon leaves of *Quercus cinera*. It is identical apparently with our *Taphria coerulescens*.

Ascomyces rubro-brunneus Peck. 1887. This was reported by Peck upon leaves of *Quercus rubra*.

It is quite probable that all the above species belong in the genus *Taphria* but their specific standing we have not determined with sufficient certainty to refer to the matter in this connection.

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alphabetically with the year of publication printed directly beneath the name of the author.

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1897 Some Fungi from Alabama. Collected chiefly during the years 1889-1892. Bull. of the Cornell University 3:1-50. On page 13 *Taphrina coerulescens* is reported from Alabama upon *Quercus aquatica, cinerea, falcata obtusiloba, nigra* and *phellos.*

Cooke, M. C.

1878 Ravenel's American Fungi. Grevillea 6:129-146. On page 142 is the original description of *Ascomyces quercus* sp. n. This is reported from South Carolina upon leaves of *Quercus cinerea.*

Cooke, M. C.

1883 North American Fungi. Grevillea 11:106-111. On page 106 are notes upon *Ascomyces quercus* Cooke.

Desmazieres, J.—B. H.—J.

1848 Dizieme notice sur les plantes cryptogames recemment decouvertes en France. Ann. Sci. Nat. Bot. III,10:342-361. On pages 345-346 he establishes the new genus *Ascomyces* Mont. et Desm. to hold *Ascomyces coerulescens* Mont. et Desm. sp. n.

Fries, E.

1815 Observationes Mycologicæ. 1:217. On the page cited Fries gives the new genus *Taphria* Fr. and lists but a single species under it, ie *"Taphria populina"* on leaves of *Populus nigra, tremula* and *dilatata.* Fig 3 on plate 8 shows *Taphria populina.*

Fries, E.

1825 System orbis vegetabilis. On page 317 he gives the generic name *Taphrina* which he substitutes

for the previously published name *Taphria*. His reason for so doing is stated to be to avoid confusion with the genus of insects named Taphria.

Fries, E.

1829 Systema mycologicum. On pages 520-521 are notes on *Taphrina* Fr.

Fries, E.

1849 Summa vegetabilium scandinaviæ seu enumeratio systematica et critica....2:518. On the page cited is a description of *Taphrina* Fries with *Taphrina populina* as the first mentioned species.

Fuckel, L.

1860 Enumeratio Fungorum Nassoviæ. On page 29 he gives a description of the new genus and species *Exoascus pruni*, and gives a figure of the same species in figure 26 on plate 1. This establishes the genus *Exoascus*.

Fuckel, L.

1869 Symbolæ Mycologicæ. Beitraege zur Kenntniss der rheinischen Pilze. On page 252 he gives under the genus *Exoascus* Fuckel the following species: *pruni, deformans* and *alni*. Fuckel here states his preference for separating the multispored species from the 8-spored, assigning the former to the genus *Ascomyces* and the latter to the genus *Exoascus;* and his objection to the inclusion of both genera in the one genus *Taphrina* as done by Tulasne in 1866.

Ikeno, S.

1903 Die Sporenbildung von Taphrina-Arten. Flora 92:1-31. pl. 1-3. fig. 1-2.

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1885 Om svampslaegtet Taphrina och dithoerande svenska arter. Oefversigt af K. Vetens. Akad.

Forhandl. 1885:29-47. pl. 1. Figrues of the following species are given: *Taphrina borealis, carnea, nana, polyspora, potentillae* and *sadebeskii.*

Johanson, C. J.

1885 Studien ueber die Pilzgattung Taphrina. Bot. Centralbl. 33:222-223, 251-256, 284-287. The author reports *Taphrina coerulescens* in Sweden and Norway.

Kruch, O.

1890 Sopra un caso di deformazione (Scopazzo) der rami dell' Elce. Nota preliminare. Malpighia 4:424-430. Record of *Taphrina Quercus* on *ilicis* in Italy. This fungus was described as *Exoascus Kruchii* by Vuillemin in 1891.

Patterson, F. W.

1895 A study of North American parasitic Exoascaceæ. Bull. Lab. Nat. Hist. State Univ. Iowa 3^3:89-135. pl. 1-4.

Peck, C. H.

1886 Report of the Botanist in 39th Report of the Regents of the University of N. Y. On page 50 he describes the new species *Ascomyces extencus* on *Quercus macrocarpa.* Fig. 1-3 on plate 1 represents this species which Peck states is distinct from *Ascomyces quercus* in "the character of the spote and also the spores."

Peck, C. H.

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Robinson, B. L.

1887 Notes on the Genus Taphrina. Annals of Botany 1:163-176.

Saccardo, P. A.

1880 Fungi dalmatici pauci ex herb. illustr. R. de Visiani additio uno alterove mycete ex agliaet pannonio. Michelia 2:150-153. On page 153 is a description of *Ascomyces alutaceus* Thuem. upon *Quercus robor.*

Saccardo, P. A.

1898 Sylloge Fungorum. 13:.....Host list for the species of Taphrina.

Sadebeck, R.

1887 Die Pilze (Winter 1^2:10. Sadebeck here assigns *Taphria coerulescens* to the genus *Exoascus.*

Sadebeck, R.

1893 Die parasitischen Exoasceen. Eine Monographie. Jahrb. d. Hamb. Wiss. Anst. 10^2:1-110. pl. 1-3.

Sadebeck, R.

1895 Einige neue Beobachtungen und kritische Bemerkungen ueber die Exoasceæ. Ber. Deut. bot. Gesell. 13:265-280. pl. 21.

Cchroeter, J.

1894 Protodiscineæ. Engler u. Prantl's Nat. Pflanzenfam. 1^1:157-161. fig. 136, H. and J.

Smith, W. G.

1894 Untersuchung der Morphologie und Anatomie der durch Exoasceen verursachten Spross—und Blatt—Deformationen. Forst. naturw. Zeitschr. 3:420-427, 433-465, 473-482. 1 plate and 18 text figures.

Thuemen. F. von.

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sell. Wien 29:523-524. He describes as a new species *Ascomyces alutaceus* on *Quercus pubescens.*

Tulasne, L. R.

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Vuillemin, P.

1891 L'Exoascus Kruchii sp. nov. Rev. Mycol. 13: 141-142. This species was collected by Kruch in Italy and its effect upon *Quercus ilicis* described by him in 1890.